REMARKS

This is a response to the ***Final Office Action*** dated August 4, 2003. Claims 1-2, 4-9, 17-22, 26-29, and 31-37 are pending in the present application. For the reasons provided below, withdrawal of the final rejection and reconsideration and allowance of pending claims 1-2, 4-9, 17-22, 26-29, and 31-37 in view of the following remarks are requested.

The Examiner has rejected claims 1-2, 4-9, 17-22, 26-29, and 31-37 under 35 USC §102(b) as being anticipated by U.S. patent number 5,627,402 to Hisashi Takemura ("Takemura"). For the reasons discussed below, Applicant respectfully submits that the present invention, as defined by independent claims 1, 9, 26 and 35, is patentably distinguishable over Takemura.

The present invention, as defined by amended independent claim 1, teaches, among other things, "selecting a first peak dopant concentration and a first implant energy such that at least one of capacitance, leakage current, and tuning range of the varactor device is optimized," "forming a first implant in said epitaxial layer using said first implant energy, said first implant having said first peak dopant concentration and said second conductivity type, wherein said first implant extends into said epitaxial layer a first distance," and "forming a second implant in said epitaxial layer using a second implant energy, said second implant having a second peak dopant concentration and said second conductivity type, wherein said second implant extends into said epitaxial layer a second distance, wherein said second distance is greater than said first distance." As

disclosed in the present application, the present invention forms an emitter window in an implant region of a semiconductor substrate. As disclosed in the present application, first and second implants are formed in the emitter window in an epitaxial layer of the semiconductor substrate, where the first and second implants have the same conductivity type, but have first and second peak dopant concentrations and first and second implant energies, respectively. As disclosed in the present application, by appropriately selecting the first peak dopant concentration and first implant energy of the first implant, the present invention advantageously achieves a double-implant varactor device having at least an optimized capacitance, leakage current, or tuning range.

Furthermore, as disclosed in the patent application, by appropriately selecting the second peak dopant concentration and appropriately selecting the second implant energy such that the second implant extends a greater distance into the epitaxial layer than the first implant, the present invention achieves a double-implant varactor having a minimized base resistance, which advantageously results in the varactor having an optimized quality factor ("Q"). Thus, by appropriately choosing the first and second peak dopant concentrations and first and second implant energies of first and second implants, respectively, the present invention advantageously achieves a double-implant varactor that can be selectively optimized to match the specific requirements of a particular application. For example, all of the parameters, i.e. capacitance, leakage current, tuning range, and base resistance, of the present invention's varactor can be optimized by

choosing the appropriate the first and second peak dopant concentrations and first and second implant energies of first and second implants, respectively.

In contrast, Takemura does not teach, disclose, or suggest "selecting a first peak dopant concentration and a first implant energy such that at least one of capacitance, leakage current, and tuning range of the varactor device is optimized," "forming a first implant in said epitaxial layer using said first implant energy, said first implant having said first peak dopant concentration and said second conductivity type, wherein said first implant extends into said epitaxial layer a first distance," and "forming a second implant in said epitaxial layer using a second implant energy, said second implant having a second peak dopant concentration and said second conductivity type, wherein said second implant extends into said epitaxial layer a second distance, wherein said second distance is greater than said first distance." Takemura specifically discloses variable-capacitance device 10 comprising n-type diffusion layer 14, which is formed on n-type epitaxial growth layer 13_1, and p-type diffusion layer 17, which is formed by diffusing boron atoms into n-type diffusion layer 14. See, for example, column 4, lines 46-60 and Figure 3 of Takemura. In Takemura, an area where

In Takemura, in order to achieve a desired capacitance of variable-capacitance device 10, the area where p-type diffusion layer 17 and n-type diffusion layer 14 contact each other and the impurity concentration profile of n-type diffusion layer 14 must be optimized. See, for example, Takemura, column 5, lines 66-67 and column 6, lines 1-3. In Takemura, p-type diffusion layer 17 and n-type diffusion layer 14, which determine the

capacitance of variable-capacitance device 10, are both situated above n-type epitaxial growth layer 13_1. Furthermore, Takemura fails to teach, disclose, or suggest forming first and second implants in n-type epitaxial growth layer 13_1 or any other epitaxial growth layer. As such, Takemura fails to teach, disclose, or suggest selecting a first peak dopant concentration and implant energy of a first implant in an epitaxial layer so as to optimize capacitance, leakage current, or tuning range of a varactor or selecting a second peak dopant concentration and implant energy of a second implant in the epitaxial layer to achieve a varactor having a minimized base resistance. For the foregoing reasons, Applicant respectfully submits that the present invention, as defined by independent claim 1, is not suggested, disclosed, or taught by Takemura.

The present invention, as defined by independent claims 9, teaches, among other things, selecting a second peak dopant concentration and a second implant energy "with relation to said first peak dopant concentration and said first implant energy such that the base resistance of the varactor device is minimized." Also, the present invention, as defined by independent claim 9, teaches similar limitations and provides similar advantages as the present invention as defined by independent claim 1 as discussed above. Further, the present invention, as defined by independent claims 26 and 35, teaches, among other things, similar limitations and provides similar advantages as the present invention as defined by independent claim 1 as discussed above. As such, and based on the foregoing reasons, independent claims 9, 26, and 35 are patentably distinguishable over Takemura. Thus, claims 2, 4-8, and 17-19 depending from

independent claim 1, claims 20-22 depending from independent claim 9, claims 27-29 and 31-34 depending from independent claim 26, and claims 36 and 37 depending from independent claim 35 are, *a fortiori*, also patentably distinguishable over Takemura for at least the reasons presented above and also for additional limitations contained in each dependent claim.

The Examiner has further rejected claims 1-2, 4-9, 17-22, 26-29, and 31-37 under 35 USC §102(b) as being anticipated by U.S. patent number 5,854,117 to Huisman et al. ("Huisman"). For the reasons discussed below, Applicant respectfully submits that the present invention, as defined by independent claims 1, 9, 26 and 35, is patentably distinguishable over Huisman.

In contrast to the present invention as defined by independent claim 1 discussed above, Huisman specifically discloses a varicap diode having epitaxial layer 2, which includes first zone 3 comprising dopant atoms of a first conductivity and third zone 7 comprising an implantation of dopant atoms of the first conductivity. See, for example, column 4, lines 34-46 and Figure 5 of Huisman. In Huisman, the dopant dose and implantation energy utilized to form first zone 3, the type of dopant and the dopant dose unitized to form third zone 7, and the thickness and dopant dose of epitaxial layer 2 are determined by the desired frequency band of operation of the varicap diode. See, for example, Tables 1, 2, and 3 of Huisman. However, Huisman fails to teach, disclose, or suggest optimizing at least one of capacitance, leakage current, or tuning range of a varactor by appropriately selecting a first peak dopant concentration and implant energy

of a first implant in an epitaxial layer. In fact, Huisman fails to even discuss optimizing leakage current by any means.

Furthermore, in Huisman, a scattering oxide layer, i.e. scattering oxide 6, is grown over epitaxial layer 2 to provide a more uniform distribution of dopant atoms in subsequent implantations. See, for example, column 4, lines 41-43 and Figure 2 of Huisman. Thus, by utilizing scattering oxide 6 to ensure a more uniform dopant distribution, Huisman teaches away from selecting a peak dopant concentration and implant energy of a first implant prior to implantation to achieve optimization of at least one of varactor capacitance, leakage current, and tuning range. For the foregoing reasons, Applicant respectfully submits that the present invention, as defined by independent claim 1, is not suggest, disclosed, or taught by Huisman.

In addition to the limitations and advantages discussed above for independent claim 1, the present invention, as defined by independent claim 9, teaches, among other things, selecting a second peak dopant concentration and a second implant energy "with relation to said first peak dopant concentration and said first implant energy such that the base resistance of the varactor device is minimized." In contrast, Huisman specifically discloses adapting the thickness of the epitaxial layer to achieve a varicap diode having a low series resistance. See, for example, Huisman, column 6, lines 48-50. However, Huisman does not teach, disclose, or suggest utilizing an implant having a peak dopant concentration and implant energy to reduce the resistance of the varicap diode. Furthermore, by utilizing scattering oxide 6 to ensure a more uniform dopant distribution

as discussed above, Huisman teaches away from selecting a peak dopant concentration and implant energy of a second implant prior to implantation to achieve minimized varactor base resistance.

Further, the invention, as defined by independent claims 26 and 35, teaches, among other things, similar limitations and provides similar advantages as the invention defined by amended independent claim 1 discussed above. As such, and based on the foregoing reasons, independent claims 1, 9, 26, and 35 are patentably distinguishable over Huisman. Thus, claims 2, 4-8, and 17-19 depending from independent claim 1, claims 20-22 depending from independent claim 9, claims 27-29 and 31-34 depending from independent claim 26, and claims 36 and 37 depending from independent claim 35 are, *a fortiori*, also patentably distinguishable over Huisman for at least the reasons presented above and also for additional limitations contained in each dependent claim.

Based on the foregoing reasons, the present invention, as defined by independent claims 1, 9, 26, and 35, and claims depending therefrom, is patentably distinguishable over the art cited by the Examiner. Thus, claims 1-2, 4-9, 17-22, 26-29, and 31-37 pending in the present application are patentably distinguishable over the art cited by the Examiner. As such, and for all the foregoing reasons, the withdrawal of the final rejection and an early allowance of claims 1-2, 4-9, 17-22, 26-29, and 31-37 pending in the present application is respectfully requested.

Respectfully Submitted,
FARJAMI & FARJAMI LLP

Michael Farjami, Esq.
Reg. No. 38, 135

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Michael Farjami, Esq.
FARJAMI & FARJAMI LLP
16148 Sand Canyon
Irvine, California 92618
Telephone: (949) 784-4600
Facsimile: (949) 784-4601

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